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METHOD AND ARRANGEMENT FOR TREATING PULP

The present invention relates to a method and arrangement for treating pulp. The method and arrangement according to the invention are especially suitable for use in production of chemical pulp in situations where gas must be removed from the pulp and where the pulp must be diluted. The invention is, of course, also suitable for use in other corresponding applications in both chemical and mechanical wood processing industry.

In the following disclosure chemical wood processing and one especial process arrangement are used only as an example of how the method and arrangement according to the invention are applicable to an industrial process. It is thus to be understood that the invention can also be used in other locations of both a chemical pulping line and totally different processes of wood processing industry.

As disclosed in prior art, chemical wood processing can be considered to start from the digester, in which the wood material fed into the digester as chips is treated so that subsequent to the digester the pulp is mainly in fibrous state or it can at least be easily disintegrated into fibrous state. The so-called brown stock discharged from the digester is washed and taken into delignification stage, in which oxygen is usually used as the delignification chemical. The delignification stage ends with washing, which can be accomplished by means of wire or drum presses, pressurized drum presses or suction drum presses. The so-called DrumDisplacer™-washer that in the recent years has become relatively popular, is by its working principle a pressurized drum washer, but a typical feature of it is that a number of washing stages have been arranged therein. In most cases the washers discharge the pulp in medium consistency, i.e. at a consistency of about 10 %. The presses can, however, discharge the pulp in a consistency of about 20 %.

Very often the washing is performed with apparatus that require that the feed consistency of the pulp is relatively low. The requirements for the feed consistency range from a few percent to close to ten percent depending on the apparatus used.

In other words, the brown stock, or, more generally, pulp has to be diluted prior to its introduction into a washing apparatus. Also, it has to be kept in mind that the brown stock or pulp should be as gas-free as possible as the presence of gas in the pulp has a negative effect both in the washing/filtering operation and in the treatment of the filtrates later on. For instance, filtrates having a high gas content tend to start foaming when they are pumped further, just to name one problem caused by excess gas in the filtrates.

The so-called delignification process is followed in the process by the pulp screening, the aim of which is to separate the material unwanted for further process and especially for the final product from the pulp. Screening is, however, an operation requiring the consistency of the pulp to be diluted to about 1 - 3 %, depending on some degree on the apparatus to be used. In order to dilute the pulp from the discharge consistency of the washing apparatus of over 20 % to the consistency of a few percent required by the screening apparatus, an intermediate tank is arranged in the process subsequent to the washing apparatus for pumping the necessary amount of dilution liquid. In most cases the pulp from the washing apparatus is discharged into the intermediate tank through the top thereof, whereby the pulp is discharged directly adjacent the dilution mixer located at the bottom of the tank and is quickly mixed with the dilution liquid introduced preferably through the mixer so that pulp in relatively even consistency can be pumped from the tank into the subsequent process stage, the screening apparatus.

Several problems have, however, been observed in the process described above.

Firstly, especially after the oxygen stage there are relatively much gaseous substances in the pulp that are not separated from the pulp even during washing, but they pass through the washer to the intermediate tank. In the atmospheric condition of the intermediate tank the gases lift a portion of the fibres in the diluted pulp to the level of the surface of the liquid in the tank, whereby a dense fibre cover is formed on the surface. The fibre cover will prevent almost all separation of gases from the diluted pulp, whereby the gases pass with the pulp to the screening apparatus and from there further into the process. Additionally the presence of gas

in the pulp is always detrimental to the pumping, when the gas content of the pulp reaches the value of a few per cent.

Secondly, the fibre cover will over time cause the fibres remaining on the surface of the pulp to be spoiled by the influence of air. When the tank is also used as a buffer tank, the surface of which is sometimes drained very low, this spoiled fibre material is mixed with the rest of the diluted pulp during the low surface condition, whereby the spoiled fibre material can be passed on as far as to the final product and cause a momentary deterioration of its quality.

Thirdly, as the fibre cover is mixed with the rest of the pulp during the low surface condition, the consistency of the diluted pulp increases momentarily, because the consistency of the fibre cover floating in the tank is much higher than the consistency of the rest of the pulp in the tank. Subsequent to this it only depends on the dilution regulation system of the tank whether the change of consistency is seen in the whole process or whether the regulation system reacts correctly and fast enough to even out the consistency to a desired level.

The size of the intermediate tank can be seen as a fourth problem, completely separate from the previous problems, the size varying from some tens of cubic meters to hundreds of cubic meters. The size of the tank is determined on the other hand mostly by the buffering needs of the process, i.e. the need to store pulp in case of fluctuations in the production of the digester side of the process. On the other hand, though, the consistency of the stored pulp is also important, because doubling the consistency would reduce the required size of the tank by half. Correspondingly, tripling the consistency would reduce the required size to a third of the original. With such big differences between the high and low consistency tanks it is possible to achieve savings in both costs and space by changing to a higher consistency.

It has been proposed to solve this gas problem by means of an AirSep™ pump produced by Sulzer Pumps Finland Oy, the pump being arranged after the intermediate tank as a feed pump for the screening apparatus. Even though the

pump is capable of removing a considerable amount of the gas, functional problems have been noted in some screening apparatuses that are more sensitive to gas contained by the pulp. These problems can express themselves for example so that gas is slowly accumulated into the screening apparatus, the gas being then discharged in greater amounts into the subsequent process, causing various unwanted phenomena there.

The above-mentioned problems can be solved by a number of ways. If the fibre cover or fibre raft (as it also can be called) is considered as the problem, it is possible to try and avoid its formation by using the ways disclosed in the patent application FI 971330 by Sulzer Pumps Finland or patents FI 98836 and FI 100011 by Sulzer Pumps Finland. These publications disclose either different ways of feeding the pulp over the pulp already in the tank or into at least the surface layer thereof or uniform diluting of the pulp in the tank.

These solutions do not, however, address the removal of gas in the pulp, although they improve the separation of gas from pulp by at least partially preventing the formation of the fibre raft.

However, if the goal is to more efficiently remove gas from the pulp, it must according to our understanding be done in a consistency higher than the screening consistency. It has namely been seen in practice that gas is more easily separated from the pulp when the consistency of the pulp is higher. This rule is true to at least consistencies up to 12 - 15 per cent.

Further, the increase of consistency to alleviate the gas problem will also help the problem with the size of the tank.

Among the advantages of the use of the method according to the invention can be listed, for example, that:

- the gas content of the pulp is essentially lower than previously, whereby the subsequent part of the process functions better,
- a smaller intermediate tank is sufficient, whereby there are savings in both

space and construction costs.

The method for treating pulp according to the invention, in which method pulp is moved from a first, higher consistency to a treatment in a second, lower consistency, is characterized in that

a) gas is separated from the pulp in a consistency higher than said second consistency,
b) pulp is pumped in the low consistency treatment, and
c) pulp is diluted to said second consistency prior to the treatment in said consistency.

The arrangement for treating pulp according to the invention, the arrangement comprising at least a first pulp treatment apparatus, from which pulp is discharged in a first consistency, a second pulp treatment apparatus, from which pulp is discharged at a first consistency, a second pulp treatment apparatus requiring a second consistency, lower than the discharge consistency of the first pulp discharge apparatus, and a pump for transferring pulp into the second pulp treatment apparatus, is characterized in that both an apparatus for degassing the pulp at a consistency higher than said second consistency and an apparatus for diluting the pulp into the consistency required by the second pulp treatment apparatus is arranged between the first and second pulp treatment apparatuses.

Other characterizing features of the method and arrangement according to the invention are disclosed in the appended claims.

In the following, the method and arrangement according to the invention are described in more detail, with reference to the appended drawings, of which
figure 1 illustrates a prior art process arrangement,
figure 2 illustrates a process arrangement according to a preferred embodiment of the invention,
figure 3 illustrates a process arrangement according to another preferred embodiment of the invention,
figure 4 illustrates a process arrangement according to a third preferred

embodiment of the invention, and

figure 5 illustrates a process arrangement according to a fourth preferred embodiment of the invention.

As shown in figure 1, a prior art process arrangement starts with a washing apparatus 5, which can, as described above, be a pressurized drum washer, suction drum washer, a wire press or a roll press, to name a few examples. Subsequent to the washing apparatus there is an intermediate tank 10, which can also be called a buffer tank or a storage tank. In any case, the tank is preferably provided with a mixer 12 as described in FI patent 90732 for mixing the dilution liquid into the pulp introduced into the tank 10. The pulp can be introduced into the tank 10 from the washer apparatus 5 through a conduit most often located on the cover 14 of the tank. The diluted pulp is discharged from the tank, from the bottom thereof, by means of a pump 16, the pump being, for example, a gas separating so-called AirSep™ pump. The pressure of the pulp is increased by means of the pump 16 for the subsequent screening stage 50 of the process.

As stated above, the prior art process arrangement does not work in an optimal way. It has, firstly, been noted that especially after the oxygen stage, oxygen delignification, there are relatively much gaseous substances present in the pulp, the substances passing through the washer 5 into the intermediate tank 10. In the atmospheric conditions of the intermediate tank 10 the gases on their part cause the relatively fast forming of a dense fibre raft on the surface of the pulp, the fibre raft preventing almost totally the separation of gas from the diluted pulp, whereby the gases are trapped in the diluted pulp and are transferred further into the process with the pulp.

Secondly, the fibre raft is slowly spoiled by the influence of air and other gases. When the tank 10 is used also as a buffer tank, the surface of which is sometimes drained very low, the spoiled fibre material is mixed with the rest of the diluted pulp during the low surface condition, whereby the spoiled fibre material can be passed on as far as to the final product and cause a momentary deterioration of its quality.

Thirdly, as the fibre raft is mixed with the rest of the pulp, the consistency of the diluted pulp increases momentarily, because the consistency of the fibre cover floating on the surface of the tank 10 is much higher than the consistency of the rest of the pulp in the tank 10.

The size of the intermediate tank 10 can be seen as a fourth problem, the size varying from some tens of cubic meters to hundreds of cubic meters. The size of the tank 10 is mostly determined by the buffering needs of the process, i.e. the need to store pulp in case of fluctuations in the production of the digester side of the process, a large tank 10 can be seen as a problem because of both its space requirements and its production costs.

As a solution to the problem it is proposed to dilute the pulp subsequent to the tank, whereby the pulp would be stored in the buffer tank in higher consistency. It is at the same time proposed to remove gas from the pulp in higher consistency before diluting the pulp.

Figures 2 - 4 show process arrangements according to some preferred embodiments of the invention, the arrangements starting from the washing apparatus 5 as in prior art. Subsequent to that, however, the process arrangement has been changed so as to allow storing the pulp in the intermediate tank in higher consistency. The process arrangement is shown to end in the screening stage 50, which in practice thereby preferably remains unchanged, like the washing apparatus, despite the changes in the process part therebetween.

Figure 2 shows a process arrangement according to a preferred embodiment of the invention, in which pulp is discharged into the intermediate tank 20 from the washing apparatus 5 as in prior art, in the discharge consistency of the washing apparatus, the consistency being of course higher than the consistency of the screening stage 50. In this embodiment, however, the pulp is not diluted in the intermediate tank, at least not to the consistency needed by the screening stage, but the consistency of the pulp is kept preferably equal with the discharge consistency of the washing apparatus. However, in some cases, when the

discharge consistency is very high (most usually over 14 %), pulp must diluted in the tank 20, but even in this case to only the medium consistency range of about 10 - 12 %. In the embodiment shown in the figure a bottom scraper 22 has been arranged in connection with the bottom of the tank, by means of which pulp is discharged from the tank 20 to the drop leg 24. If dilution is needed, it can preferably be done by means of said bottom scraper 22. A so-called MC pump™ 26 having gas separation capable of pumping medium consistency pulp, various alternative examples of which have been disclosed in, for example patents US 4,921,400, US 5,058,615, US 5,019,136, US 5,167,678, US 4,971,519, US 4,877,424, US 4,877,368, US 4,981,413, US 5,152,663, US 5,538,597, US 5,114,310, US 5,078,573, US 5,116,198, US 5,151,010, US 5,842,833, US 6,120,252, US 6,551,054 of Sulzer Pumps Finland, which are hereby included as reference in this disclosure, has been arranged in the bottom end of the drop leg 24. a typical feature of said MC™ pump is that a rotor producing powerful turbulence in the pulp has been arranged at least partially inside the inlet tract of the pump. In most cases the rotor is integral with the impeller of said pump. The MC™ pump 26 is used for both discharging pulp from the drop leg and separating gas. Pulp is fed into the mixer 28 by means of a pump 26, the mixer being used for diluting the pulp into the consistency of the subsequent process stage, in this example the screening stage 50.

Compared to a prior art process arrangement this process according to the invention utilises both storing the pulp in the intermediate tank and discharging pulp from the tank in a consistency higher than that of prior art, mostly in MC™ consistency, which will prevent the detrimental effects of the fibre raft formed in connection with diluting. Simultaneously with the increase of the storage consistency it has been possible to decrease the size of the tank.

The transition from AirSep™ to pumps MC™ pumps has on its part caused a considerably more efficient gas separation, whereby the further treatment of pulp in subsequent process is easier because of reduced gas content.

Figure 3 shows a process arrangement according to another preferred embodiment

of the invention. It can be used in applications in which no large buffer tank is needed, but the process is relatively stable, so that in order to ensure an even flow of pulp is sufficient to discharge pulp from the washing apparatus 5 directly into the drop leg 30, the lower end of which is connected to a so-called MC™ pump of the type mentioned above, subsequent to which there is a dilution mixer 28 and a screening stage 50.

In closer detail, there can be at least three different basic types of drop leg solutions. The first basic type can be seen as a solution most resembling the embodiment of figure 2, i.e. a situation in which the above-mentioned MC™ pump is connected to the bottom of the drop leg so, that it can discharge the drop leg directly without any auxiliary means.

In another basic type, shown in figure 3, an essentially vertical rotor 32 has been arranged inside the drop leg 30 for helping the pulp flow in the drop leg 30 downwards until the inlet of the MC™ pump. The rotor 32 can be a rotor forming only efficient turbulence or it can additionally be provided with gas separation in a way known from prior art.

In the third basic type the drop leg 30 with its rotor 32 is similar to that of the other basic type, but the pump is no longer an MC™ pump, but it's a simpler centrifugal pump that is not provided with a rotor forming efficient turbulence in its inlet. In other words it has been found that in some situations, in which the consistency of the pulp is not very high, a rotor provided in the drop leg, either with gas separation or without it, can ensure that pulp will flow to the lower end of the drop leg and from there through the inlet to the impeller of the centrifugal pump.

It must further be noted that it is common to all these alternatives shown in connection with figure 3 that gas is separated from the pulp prior to diluting the pulp to ease the subsequent process.

Figure 4 shows a process arrangement according to a third preferred embodiment of the invention. It is applicable to situations, in which pulp flow from the washing

apparatus is essentially even and no considerable buffer capacity is needed in the fibre line at this point. In fact, US patent 5,851,350, which is hereby incorporated as reference in its entirety, discloses the pumping arrangement in more detail, a typical feature of the arrangement being that the discharge screw of the washing apparatus 5, most washing apparatuses being provided with one, feeds pulp essentially directly to the inlet channel 42 of the pump 26. Thus the pump 26 does not have to be provided with a turbulence-forming rotor, even if it were preferred, especially in connection with higher consistencies. Other solutions described in US patent 5,851,350 can also be used in this construction solution, of which solutions especially the ones shown in figures 6a, 6b, 7a and 7b are mentioned without excluding other solutions. It is typical of these that a small intermediate tank has been provided between the washing apparatus and the pump, into which tank the screw of the washing apparatus feeds the pulp. Preferably the intermediate tank is pressurised, but it can also be atmospheric, whereby the solution is quite similar to the drop leg solution shown in figure 3, with the exception that the washing apparatus can be arranged on the same level with the screening stage.

It is to be noted that in connection with the above examples that even though the dilution mixer 28 has in the figures been shown as an apparatus having a rotor, the dilution mixing can also be carried out either using a static mixer or a mixer rotating on its own in the flow. In principle, a conventional centrifugal pump, or an MC^{TM} pump, can also be used as a mixer, with the liquid required for dilution being introduced into the inlet channel or inlet duct or into a specifically designed inlet duct for the dilution liquid. It is naturally possible to use centrifugal pumps designed for this purpose, too, in which the impeller is designed with mixing in mind. Since the same apparatus can, optionally, be used for both degassing the pulp or stock, and for diluting the pulp one may imagine that the degassing of pulp does not take place exactly in the discharge consistency of the upstream storage tower, the treatment apparatus or the like but in a somewhat lower consistency. However, in any case, in accordance with the invention the degassing is done at a consistency higher than the feed consistency of the treatment apparatus later in the process.

In Fig. 5 yet another embodiment of the invention has been shown. In a similar

manner as in the embodiments discussed in connection with Figs. 2 – 4, the presence of gas is harmful to the operation of various kinds of pulp washing and dewatering equipment. Also the washing and/or dewatering or filtering equipment requires often dilution of pulp to a consistency well below 10 percent. Thus Fig. 5 illustrates a process arrangement where pulp, or brown stock is introduced in at least medium consistency to a storage tower, or a blow tank (into which brown stock from a digester is blown) or some other vessel 20, from where the pulp is introduced into a pump 26 capable of pumping pulp of at least medium consistency. Preferably the pump 26 is capable of separating gas from the pulp while pumping the pulp. The pump 26 transfers the pulp to a washing, filtering or dewatering unit 55. A common feature to the unit 55 whether it is a vacuum drum washer, a pressurized drum washer, a wash press, or a wire press, just to name a few options without any intention to limit the scope of the applicable washing/filtering devices, is the need of receiving the pulp at a lower consistency. Fig. 5 suggests the use of a dilution mixer 28 between the pump 26 and the washing/filtering unit 55 just as the earlier embodiments, too. However, as already mentioned before, the pump 26 could also be used for diluting the pulp whereby a separate mixer for diluting the pulp would not be required.

It should accordingly be noted that in addition to the above-mentioned so-called MC™ pump is being proposed to be used in pumping pulp and separating gas therefrom, it is also possible to use other suitable apparatuses for this purpose, the apparatuses being capable of both separating gas from the pulp and pumping the pulp in the desired consistency.

It should be noted from the above disclosure that the invention has only been described with reference to a few exemplary solutions. These solutions are not intended as limiting the invention to only the above-mentioned details, but the invention is limited only by the appended claims and the definitions therein.

WE CLAIM

1. A method of treating pulp, in which method pulp is transferred from a first, higher consistency to a treatment in a second, lower consistency, **characterized** in that

a) gas is separated from the pulp in a consistency higher than said second consistency,
b) pulp is pumped to the treatment taking place in the second, lower consistency, and
c) pulp is diluted to said second consistency prior to the treatment in said consistency.

2. A method according to claim 1, **characterized** in that pulp is diluted from said first consistency to a consistency higher than the second consistency in step a).

3. A method according to claim 2, **characterized** in that pulp is diluted from the discharge consistency of the press to medium consistency.

4. A method according to claim 1, **characterized** in that said first consistency is the discharge consistency of a washing apparatus.

5. A method according to claim 1, **characterized** in that said consistency higher than the second consistency is medium consistency.

6. A method according to claim 1, **characterized** in that the treatment taking place in low consistency is screening (50).

7. A method according to claim 1, **characterized** in that in step c) the pulp is diluted to a consistency of about 1 - 3 %.

8. A method according to claim 1, **characterized** in that step a) is performed by means of a turbulence-forming rotor (32).

9. A method according to claim 1, **characterized** in that steps a) and b) are performed by means of a so-called MC^{TM} pump.

10. A method according to claim 2, **characterized** in that said dilution is performed with the assistance of a bottom scraper (22).

11. A method according to claim 1, **characterized** in that the treatment taking place in low consistency is washing, pressing, dewatering or filtering (55).

12. An arrangement for treating pulp, the arrangement comprising at least a first pulp treatment apparatus, from which the pulp is discharged in a first consistency, a second pulp treatment apparatus the operation of which requires a second consistency lower than the discharge consistency of the first pulp treatment apparatus, and a pump for transferring pulp to the second pulp treatment apparatus, **characterized** in that both an apparatus for degassing the pulp at a consistency higher than said second consistency and an apparatus (28) for diluting pulp to the consistency required by the second pulp treatment apparatus (50) is arranged between the pump (26) and the second pulp treatment apparatus (50).

13. A pulp treating arrangement according to claim 12, **characterized** in that an apparatus (26; 32) for separating gas from pulp in higher consistency than the treatment consistency of the second pulp treatment apparatus (50) is arranged between the first pulp treatment apparatus (5) and a second pulp treatment apparatus (50).

14. A pulp treating arrangement according to claim 12 and 13, **characterized** in that said pump (26) is a gas separating pump.

15. A pulp treating apparatus according to claim 13, **characterized** in that said gas separating apparatus is a turbulence-forming rotor (32) arranged in the drop leg (30) prior to the pump (26).

16. A pulp treating arrangement according to claim 12 or 15, **characterized** in that said pump (26) is a so-called MC^{TM} pump.

17. A pulp treating arrangement according to claim 12, **characterized** in that said first pulp treatment apparatus (5) is a washing apparatus, such as a pressurized drum washer, suction drum washer, wire press or a wash press.

18. A pulp treating arrangement according to claim 12, **characterized** in that the second pulp treatment apparatus (50) is a screening apparatus.

19. A pulp treating arrangement according to claim 12, **characterized** in that said dilution apparatus is a rotary or static mixer (28).

20. A pulp treating arrangement according to claim 12, **characterized** in that said dilution apparatus is a centrifugal pump.

21. A pulp treating arrangement according to claim 12, **characterized** in that the second pulp treatment apparatus (55) is a pressurized drum washer, suction drum washer, wire press or a wash press.

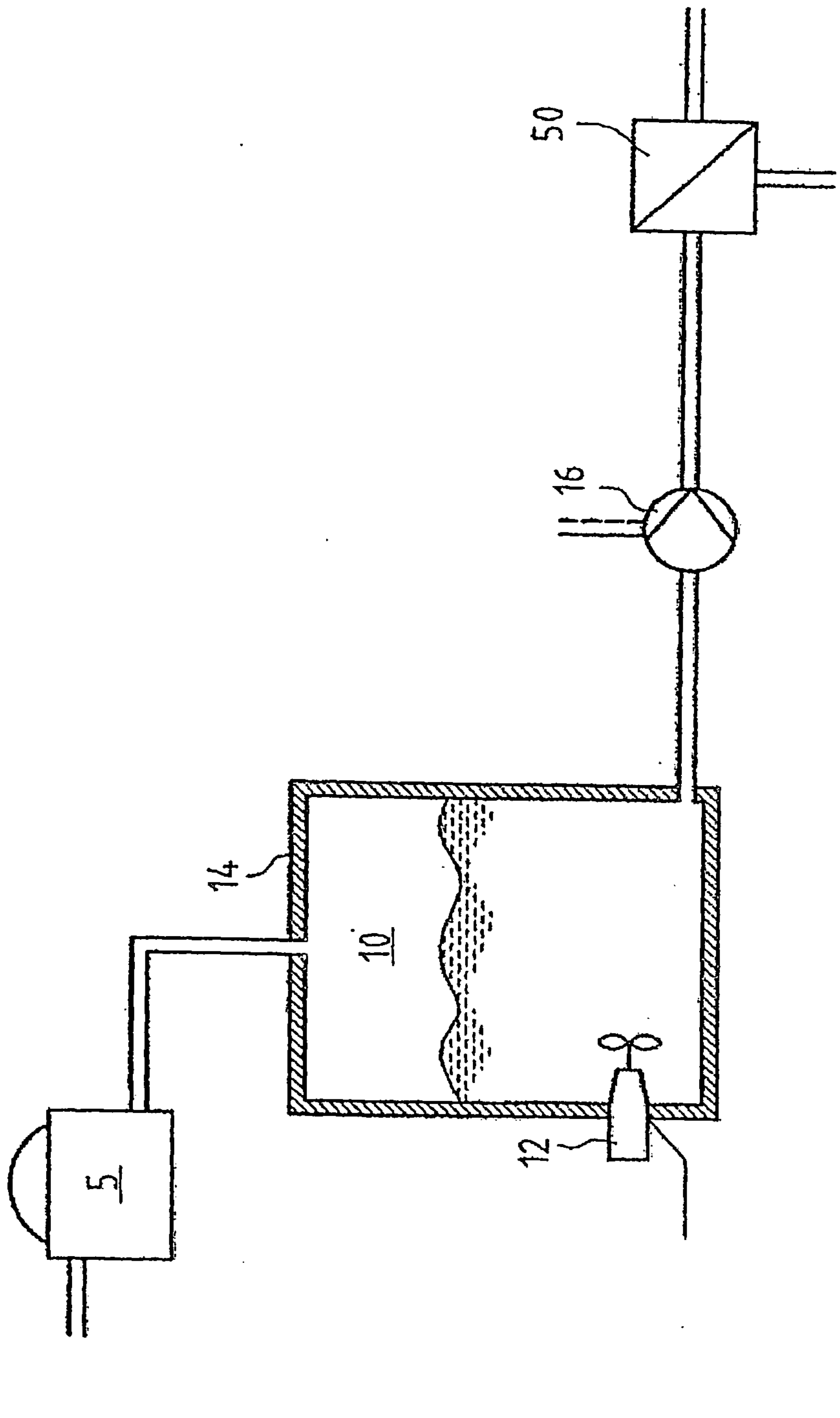

Fig. 1 (Prior art)

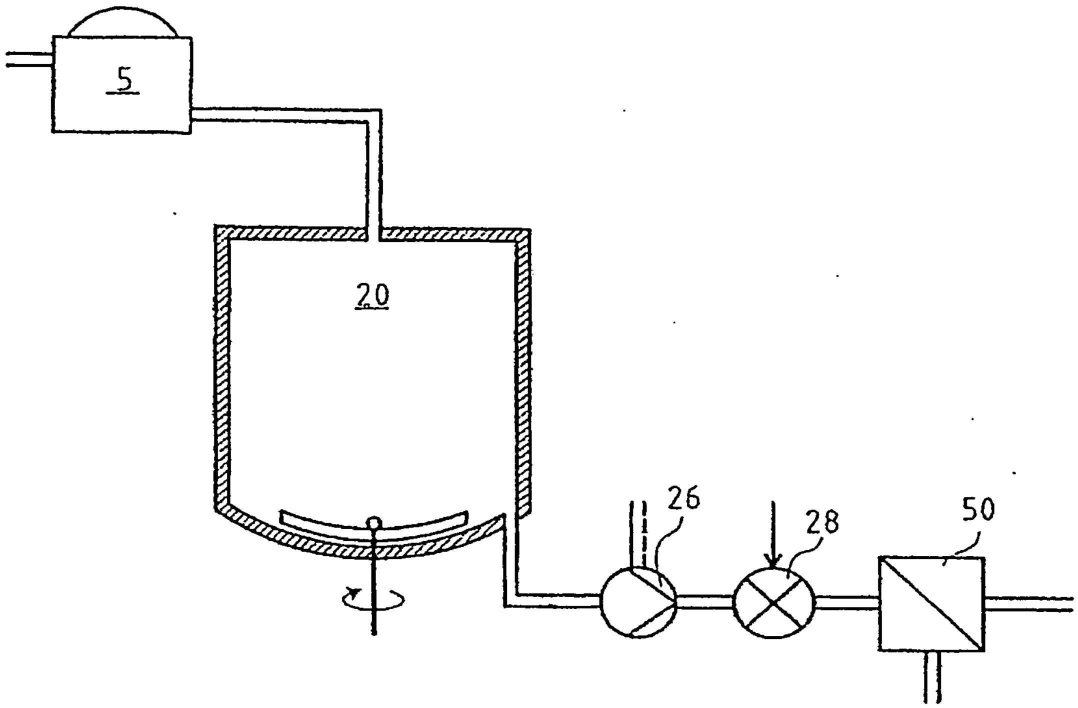

Fig. 2

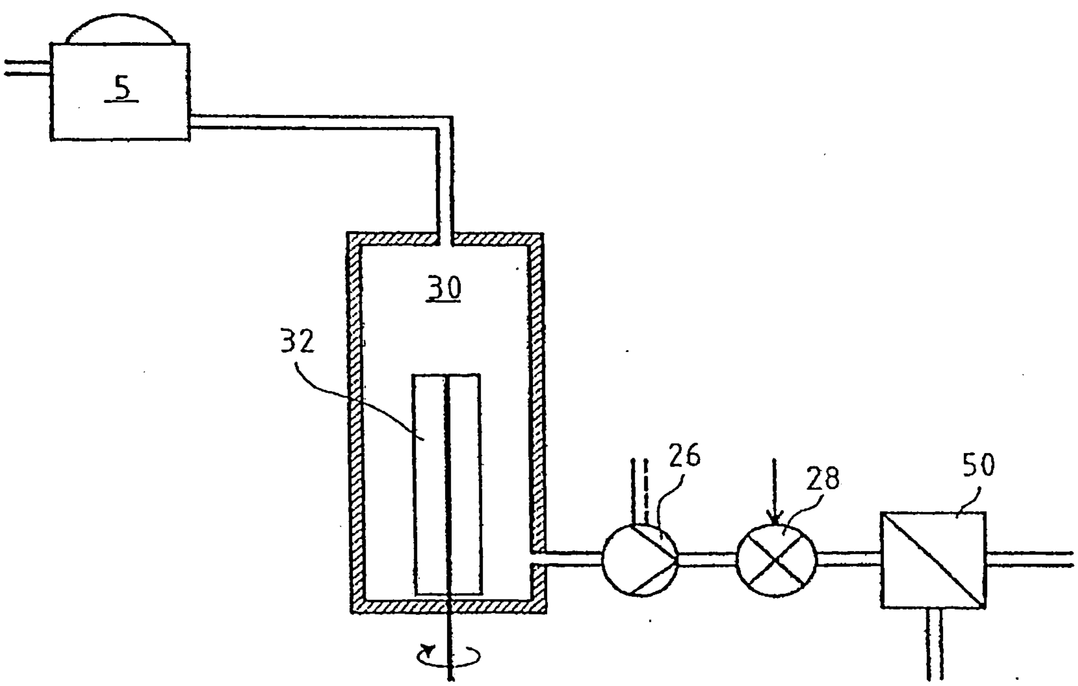

Fig. 3

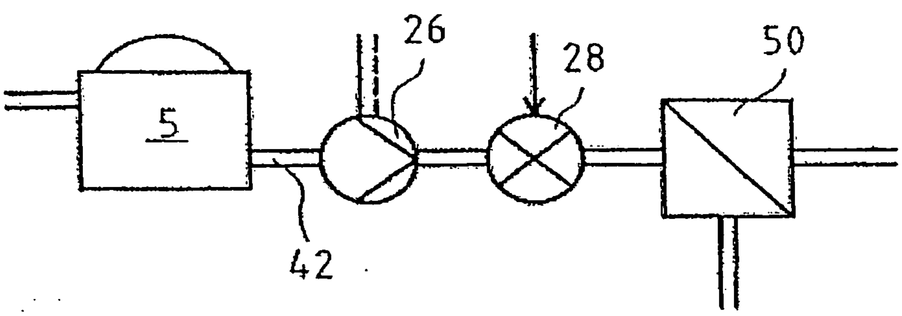

Fig. 4

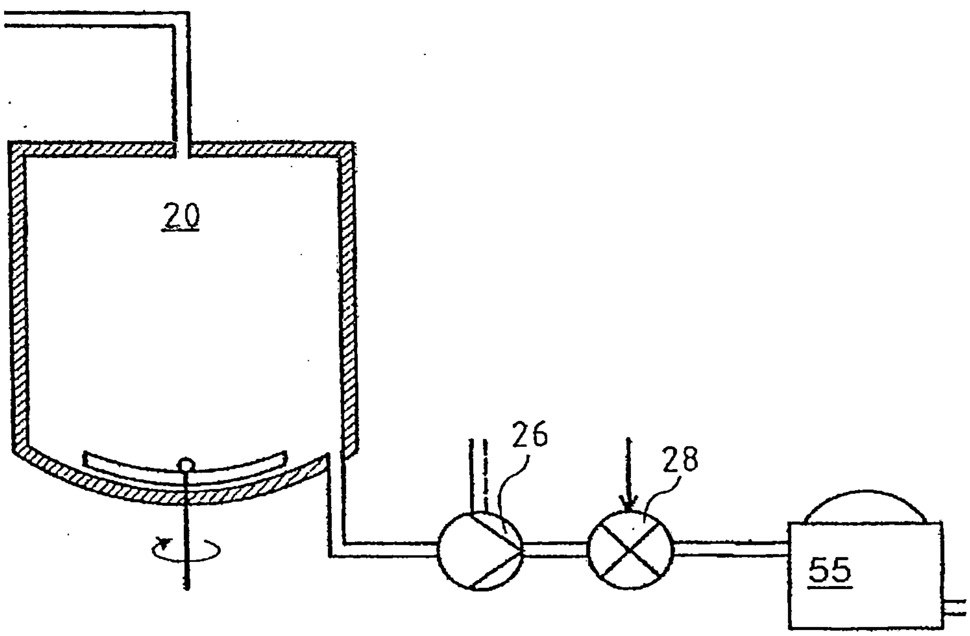

Fig. 5